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(54) PNEUMATIC TIRE

(71) We, UNIROYAL AG, a German Company, of 7 Huttenstrasse, Aachen-Rothe Erde, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pneumatic vehicle tires having reinforcing belts in the crown areas thereof.

Pneumatic tires of the "radial ply" and "bias ply" types well known in the art are frequently constructed with a reinforcing belt, commonly referred to as a breaker, interposed between the crown region of the tire carcass and the tire tread for reinforcing the latter. The breaker or belt generally comprises one or more layers or plies of parallel tire cords or cables which are substantially inextensible and are made of such materials as wire, glass fiber and textiles such as rayon and nylon. In a mono-ply belt the cords or cables are usually oriented substantially parallel to the planes of the beads and to the mid-circumferential or median equatorial plane of the tire. If the belt is of a multi-ply construction, similar but opposed bias orientation of the cords or cables with respect to the median equatorial plane of the tire are usually employed in successive plies.

It is known that tires of the type mentioned above, i.e., tires having a tread reinforced by a belt or breaker composed of superposed rubberized plies of parallel, substantially inextensible cords or cables, frequently fail because separations occur in the shoulder zones of the tires where the edges of the belt plies are severely flexed as the tire tread moves into and out of contact with the road during each revolution and become detached from the surrounding rubber. The centrifugal forces acting on the tire and the heat build-up in the tire also contribute significantly to this problem. Such separations are made even more likely by the fact that the cords or cables in the belt plies, being disposed obliquely to the median equatorial plane of the tire by virtue of the plies being cut obliquely with respect to the longitudinal direction of the cords or cables therein, have a natural tendency to spread apart or open in a fan-wise direction at their cut ends. The edges of the belt thus constitute zones or regions where the cut and free ends of the reinforcing elements, i.e., the cords or cables, by friction and by cutting, cause breaks both at their juncture with the carcass plies and the tread rubber of the tire.

One solution which has been proposed to overcome this problem entails the use of a layer of transversely oriented cables positioned radially inward of the breaker and a layer of rubber having a Shore A hardness of between 50° and 65° positioned radially inward of the first mentioned layer. This structure is illustrated in U.S. Patent No. 3,512,568.

Another solution proposed for overcoming the problem of belt ply edge separation entails the use of reinforcement layers of rubberized, radially oriented, parallel cord material positioned radially outward of the belt edges in the shoulder region of the tire and a layer of rubber having a Shore A hardness of 80° disposed about the radially inward and outward marginal portions and the edges of the belt. This structure is illustrated in U.S. Patent No. 3,598,165.

It has been found, however, that neither of the above-described structures provide a completely satisfactory solution to the problem of belt ply edge separation. Both these structures, to some extent, cause the shoulders of the tires in which they are utilized to become so stiff that driving comfort is reduced.

According to the present invention a pneumatic tire comprises a carcass; a tread overlying the crown region of the carcass; a tread reinforcing belt interposed between said tread and said crown region of said carcass in circumferentially surrounding relation to the latter, said belt including a plurality of plies of belt cords; one or two circumferentially extending rubber bodies interposed between said tread and said carcass, said body or bodies covering the radially inward marginal portions of the radially innermost ply and

the edges of said belt plies; and one or two circumferentially extending rubber pads positi ned radially inward of said rubber body or bodies and radially outward of said carcass, the Shore A hardness of said rubber body or bodies being between 70° and 80° and the Shore A hardness of said rubber pad or pads being between 55° and 70°.

Examples of tires according to the invention will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a first embodiment of tire according to the invention; and

Figure 2 is a cross-sectional view of a portion of a tire according to a second embodiment of the invention.

Referring now to the drawings, in which the same structural elements are indicated by the same numerals or letters, Figure 1 illustrates a tire 1 comprising a carcass 2 with a carcass ply 2*a* and a pair of sidewalls 3 terminating at their radially inwardmost ends in a pair of beads 4; a tread 5 formed with a plurality of grooves 5*a* surrounding the crown portion of the carcass and a reinforcing belt 6 interposed between the carcass and the tread for reinforcing the latter. The reinforcing belt 6 comprises two rubberized plies or sheets, here indicated at 7 and 8, which may be of equal or different axial widths. Each of the plies or sheets is composed of a plurality of parallel cords which are substantially inextensible and are made of such materials as wire, glass fibre, and textiles such as rayon or nylon. The axial width of the tread 5 is indicated as 2W and the median equatorial plane of the tire is indicated at X—Y. Two axially spaced rubber bodies 9 and 10 are positioned symmetrically with respect to median equatorial plane X—Y. Each of the rubber bodies, 9 and 10, covers associated edges of the belt plies 7 and 8. Two axially spaced rubber pads 11 and 12 are positioned symmetrically with respect to the median equatorial plane X—Y. The two rubber pads 11 and 12 are positioned radially inwardly of the two bodies, 9 and 10, respectively.

The bodies 9 and 10 serve to prevent undesirable belt ply edge separation. To accomplish this purpose the rubber bodies cover the edges of the belt plies 7 and 8 and the radially inward marginal portions of the radially innermost ply 8. The axial width of each of the bodies 9 and 10 is preferably approximately 25% of the axial width of the tread 5, indicated as 2W, and the major portion of the axial width of the bodies lies directly under, and is contiguous with, the belt 6. A minor portion of each of the bodies is positioned axially outward of the belt 6 and these axially outward portions protect the edges of the belt 6. In addition, the bodies 9 and 10 also cover the radially outward marginal portions of the belt 6, thereby providing additional protection.

It has been found that the hard rubber bodies 9 and 10 will function most satisfactorily in preventing belt ply edge separation when they are formed of a composition having a Shore A hardness of between 70° and 80°. Preferably, also, the bodies have a modulus of elasticity of between 60 and 80 kg/cm^2 at an elongation of 150%. It has further been found advantageous to make the radial thickness of that part of each of the bodies which covers the respective radially inward marginal portion of the ply 8 adjacent to the edge of that ply substantially equal to the radial thickness of the radially inwardmost ply 8. Thus, in Figure 1, the radial thickness of the bodies 9 and 10, in the regions indicated at 9*a* and 10*a*, respectively, is substantially equal to the radial thickness of the ply 8. In the same manner, the radial thickness of that part of each of the bodies which covers the respective radially outward marginal portion of the ply 7, adjacent to the edge of that ply, is substantially equal to the radial thickness of the radially outwardmost ply 7. Thus, in Figure 1, the radial thickness of the bodies 9 and 10, in the regions indicated at 9*b* and 10*b*, respectively is substantially equal to the radial thickness of the ply 7. Since, as above-noted, the bodies 9 and 10 have a radially inward and outward thickness, in the regions of the belt edges, generally equal to the radial thicknesses of the radially inward and outward belt plies, and since the edges of the belt 6, which is comprised of the belt plies 7 and 8, is covered by the bodies 9 and 10, the bodies 9 and 10 therefore have a radial thickness at the edges of the belt which is greater than the overall radial thickness of the belt at the belt edges. Further, Figure 1 illustrates the fact that portions of the bodies 9 and 10 may also be positioned between the plies 7 and 8 and the radial thickness of the bodies 9 and 10, in this embodiment, is therefore greater than twice the combined thickness of the plies of belt cords comprising the belt 6.

Although, as stated above, the hard rubber bodies 9 and 10 serve to satisfactorily protect the edges of the belt 6, thereby preventing belt ply edge separation, the bodies also cause the tire, in the region of the tire shoulders, these shoulders being indicated at 13, to become stiffer and more inflexible than is desirable. To counteract the stiffening effect of the bodies 9 and 10 the aforementioned axially spaced pads 11 and 12, which are made of a relatively soft rubber composition are utilized. These pads 11 and 12 are interposed between the bodies 9 and 10, respectively, and the carcass ply 2*a*, and insure that the tire shoulders 13 are suffici-

ently flexible so that the tire may provide satisfactory service. The pads 11 and 12 illustrated in Figure 1 each have an axial width substantially equal to, or somewhat greater than, 25% of the tread width 2W. They are, however, axially offset or "staggered" with respect to the bodies 9 and 10. The pads 11 and 12 therefore each extend from a point axially outward of the axially inwardmost portion of the bodies 9 and 10 with which they are respectively associated, to a point axially outward of the axially outwardmost portion of the bodies 9 and 10 with which they are respectively associated. In this regard it will be noted that, in the embodiment illustrated in Figure 1, the bodies 9 and 10 do not extend axially outwardly of the shoulders 13, although the pads 11 and 12 do extend axially outwardly of the shoulders 13.

It has been found that the soft rubber pads 11 and 12 will function most satisfactorily in providing adequate shoulder flexibility when they are formed of a composition having a Shore A hardness of between 55° and 70°. Preferably also they have a modulus of elasticity of between 45 and 70 kg/cm^2 at an elongation of 300%. It has further been found advantageous to make the radial thickness of each of the pads 11 and 12, immediately inwardly of the edges of the belt 6, at least as great as the radial thickness of the overlying part of the bodies 9 and 10 respectively, associated therewith. Thus, the radial thickness of the pads 11 and 12, in the regions indicated at *11a* and *12a*, respectively, is at least as great as the radial thickness of the bodies 9 and 10 in the regions indicated at *9a* and *10a*, respectively.

Although in the foregoing discussion two axially spaced pads, 11 and 12, and two axially spaced bodies, 9 and 10, were illustrated, it should also be understood that a single body and a single pad could also be utilized. In this latter case the single body would approximate bodies 9 and 10 in the region of the edges of the belt 6 and would taper to a minimal radial thickness in the region of the median equatorial plane, X—Y. In the same manner a single pad would approximate the pads 11 and 12 in the region of the edges of the belt 6 and would taper to a minimal radial thickness in the region of the median equatorial plane, X—Y. It will be understood of course that in the instance where a single body is utilized it will have an axial width approximately equal to the axial width of the tread, 2W. In a similar manner, if a single pad is utilized it will have an axial width exceeding the axial width 2W of the tread 5.

Turning now to Figure 2, there is illustrated an alternative embodiment of the structure illustrated in Figure 1. Figure 2 is a cross-sectional view of a portion of a tire and it illustrates one-half of the tread, the axial width thereof being indicated as W, one shoulder, indicated at 13, and a portion of one sidewall, indicated at 3. Figure 2 also illustrates a belt 6 which comprises three rubberized plies indicated at 20, 21 and 22, these plies being constructed in the same manner, and of the same materials as plies 7 and 8, previously discussed. Figure 2 also illustrates a body 23 made of a relatively hard rubber composition and a pad 24 made of a relatively soft rubber composition, the body 23 and the pad 24 functioning in the same manner, and for the same purpose as the body 10 and the pad 12, respectively, previously discussed.

Turning first to the body 23, it will be noted that it is made from three strips or sections *23a*, *23b* and *23c*, the separations between these strips being indicated by dashed lines. In this embodiment each of the plies comprising the belt 6 has a strip of hard rubber adhered to it. The strip, which has the same composition as that of the bodies 9 and 10, discussed above, has a radial thickness in the region of the edge of the ply substantially equal to twice the radial thickness of the ply. The strip also covers a marginal portion of one surface of the ply with which it is associated and the radial thickness of the strip covering the aforesaid marginal portion in the region of the edge of the ply is substantially equal to the radial thickness of the ply. Thus, ply 20 and strip *23c* are adhered to one another and strip *23c* covers the edge and the radially inward portion of the ply 20. In the same manner plies 21 and 22 are adhered to strips *23b* and *23a*, respectively, and these two strips cover the edges and the radially outward marginal portions of the plies with which they are associated. It will be noted that the strips are so staggered or tapered that strip *23c* extends axially outward to the greatest degree while strip *23c* extends axially outward to the least extent. It will be clear of course that after vulcanization of the tire the three strips *23a*, *23b* and *23c* will form an integral unit 23 comparable to the body 10, the radial thickness of the body 23, in the region of the edge of the belt 6, is generally equal to twice the combined radial thicknesses of the plies 20, 21 and 22. The axial width of the body 23 is between 45% and 50% of the axial width of the tread, and the body 23 extends axially outward beyond the shoulder 13.

Turning now to the pad 24, it is noted that it is of the same composition as the previously discussed pads 11 and 12, and that the pad 24 performs the same function in the same manner as the pads 11 and 12. The pad 24 has an axial width of between 45% and 50% of the axial width of the tread, and it extends axially outward of the body 23. The

radial thickness of the pad 24 in the region indicated at 25 at the edge of the belt is at least as great as the radial thickness of the overlying part of body 23 indicated at 26.

WHAT WE CLAIM IS:—

1. A pneumatic tire comprising: a carcass; a tread overlying the crown region of the carcass; a tread reinforcing belt interposed between said tread and said crown region of said carcass in circumferentially surrounding relation to the latter, said belt including a plurality of plies of belt cords; one or two circumferentially extending rubber bodies interposed between said tread and said carcass, said body or bodies covering the radially inward marginal portions of the radially innermost ply and the edges of said belt plies; and one or two circumferentially extending rubber pads positioned radially inward of said rubber body or bodies and radially outward of said carcass, the Shore A hardness of said rubber body or bodies being between 70° and 80° and the Shore A hardness of said rubber pad or pads being between 55° and 70°.

2. A tire according to claim 1 including two rubber bodies, each of said bodies being axially spaced from the other and covering a respective radially inward marginal portion of the radially innermost ply and respective edges of said belt plies.

3. A tire according to claim 2 in which each of said bodies further covers a respective one of the radially outward marginal portions of the radially outermost ply of said belt.

4. A tire according to claim 3, in which the radial thickness of that part of each of said bodies which covers the respective radially inward marginal portion of the radially innermost ply is substantially equal to the radial thickness of the radially innermost ply, adjacent to the edge of that ply.

5. A tire according to claim 3 in which, at the marginal edges of the belt, the radial thickness of that part of each of said bodies which covers the edges of said belt plies substantially equal to twice the combined radial thickness of the plies of belt cords.

6. A tire according to claim 3 in which the radial thickness of that part of each of said bodies which covers the respective radially outward marginal portion of the radially outermost ply of said belt is substantially equal to the radial thickness of the radially outermost ply, adjacent the edge of that ply.

7. A tire according to any one of claims 2 to 6 in which the bodies are positioned symmetrically with respect to the median equatorial plane of the tire.

8. A tire according to any one of claims 2 to 7 and including two rubber pads, each of said pads being axially spaced from the other and being positioned radially inward of a respective one of said bodies.

9. A tire according to claim 8 in which, at the marginal edges of said belt, the radial thickness of each of said pads is at least as great as the radial thickness of the radially inward part of the body associated therewith.

10. A tire according to claim 8 or claim 9 in which said pads are positioned symmetrically with respect to the median equatorial plane of the tire.

11. A tire according to any one of claims 8 to 10 in which the axial width of each of said bodies or each of said pads is approximately 25% of the axial width of said tread.

12. A tire as claimed in any one of claims 8 to 10 in which the axial width of each of said bodies or said pads is between 45% and 50% of the axial width of said tread.

13. A tire as claimed in claim 8 in which each of said pads extends axially outward of the body associated therewith.

14. A pneumatic tire substantially as herein described with reference to Figure 1 or Figure 2 of the accompanying drawings.

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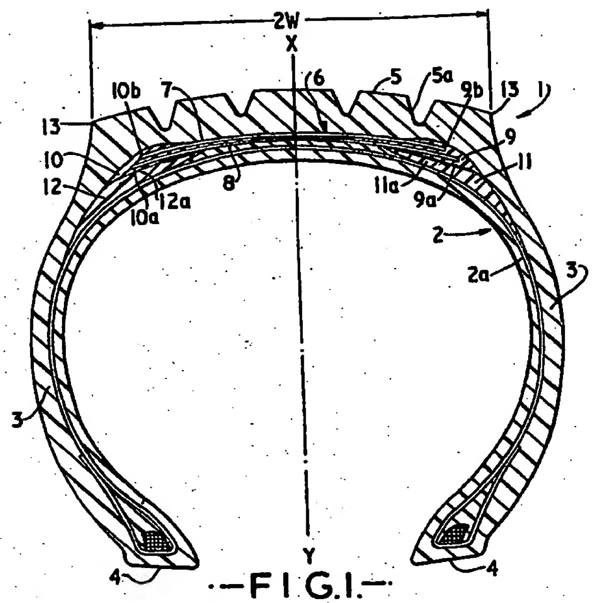
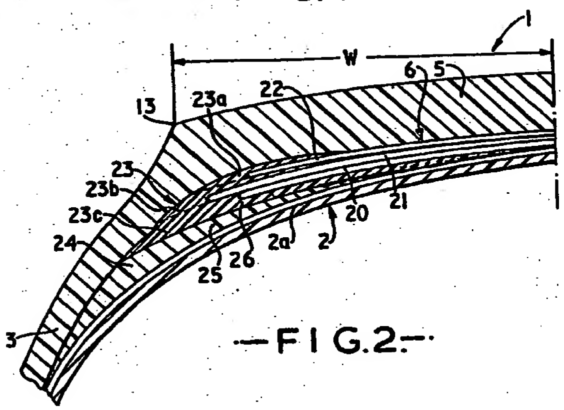
1462656 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*



—FIG.1.—



—FIG.2.—